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THE VERTICAL EXTENT OF NORTH-WESTERLY WINDS OVER IRAQ IN SUMMER

By S. P. PETERS, B.Sc., A.Inst.P.

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THE VERTICAL EXTENT OF NORTH-WESTERLY WINDS OVER IRAQ IN SUMMER

By S. P. PETERS, B.Sc., A.Inst.P.

In the navigation of aircraft over Iraq and the Persian Gulf during the summer months it would be useful, particularly in connection with a return passage from India, to have some knowledge of the possible vertical extent of the north-westerly winds which prevail there at that season. It is well known that near the surface strong winds from between N. and W. are common over Iraq, particularly by day, during the period that the SW. monsoon is blowing over India, namely June to September; these might, at times, seriously delay, or considerably prolong the time of passage of an aircraft engaged in flying westwards or north-westwards over that region. From pilot-balloon observations made over a period of 9 years at Hinaidi (Baghdad) it is revealed that in July, at a height of 1,500 feet above the ground, the wind on 80 per cent of occasions was north-westerly or northerly of speed greater than 15 m.p.h., while on 36 per cent of occasions the wind was likewise from N. or N.W. but of speed greater than 31 m.p.h. Similarly, at Shaibah near Basra, the corresponding figures are 76 per cent and 40 per cent. If, then, there should be any decrease or reversal of the wind occurring at a reasonable height, a pilot by availing himself of it could thereby materially reduce his time of passage.

From theoretical considerations it is to be anticipated that north-westerly winds will normally extend up to 6,000 feet over Iraq in each of the months June to September inclusive, since the mean pressure gradients there up to that height[1] are favourable for such winds. The pressure gradient at 10,000 feet, however, is rather indefinite, though it appears to be mainly for westerly winds in June and September; consequently there is some reason to expect that the prevailing north-westerlies at lower levels in the summer months will commonly be replaced at a height usually between 6,000 and 10,000 feet by a wind from some other direction.

An inspection of the summaries of percentage frequency of upper winds given for Hinaidi and Shaibah for the months June to September inclusive, in Tables I and II provides some preliminary information on the matter. These tables give summaries for the heights 1,500 feet, 3,000 feet, 6,000 feet and 10,000 feet in the form recommended by the International Commission for Air Navigation. (On adding up the total percentage frequencies given in the bottom row of each section of the tables together with the percentage of 0–3 m.p.h., for any height of any month, the sum may not be exactly 100, owing to the percentages having been rounded off to the nearest integer.) It is at once apparent from them that in each of the months considered at both Hinaidi and Shaibah the prevailing wind direction at all heights is N. or

[1] Monthly normal isobars above sea level over India and neighbourhood. *India Met. Dept. Sci. Notes* 1, No. 8, 1931.

TABLE I—PERCENTAGE FREQUENCIES OF UPPER WINDS

HINAIDI 33° 17′ N. 44° 29′ E. Height 106 feet.

	June (1922–30).								July (1922–30).							
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
m.p.h.	1,500 ft. Total cases, 260. 0–3 m.p.h. 1%.								1,500 ft. Total cases, 263. 0–3 m.p.h. 2%.							
4–15	9	2	2	1	1	—	2	6	3	1	1	—	—	1	3	6
16–31	24	4	1	—	2	1	1	20	18	2	—	—	—	—	—	26
32–47	11	1	—	—	—	—	—	9	11	—	—	—	—	—	—	22
Over 47 ..	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	2
Total ..	44	7	3	1	3	1	3	36	33	3	1	—	—	1	3	56
m.p.h.	3,000 ft. Total cases, 254. 0–3 m.p.h. 2%.								3,000 ft. Total cases, 259. 0–3 m.p.h. 1%.							
4–15	10	3	1	2	2	1	5	8	5	—	2	1	—	—	5	12
16–31	18	3	—	1	2	1	1	29	13	1	—	—	—	—	2	38
32–47	5	—	—	—	—	1	—	5	3	—	—	—	—	—	—	14
Over 47 ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Total ..	33	6	1	3	4	3	6	42	21	1	2	1	—	—	7	65
m.p.h.	6,000 ft. Total cases, 214. 0–3 m.p.h. 0%.								6,000 ft. Total cases, 203. 0–3 m.p.h. 2%.							
4–15	5	1	1	1	5	5	8	11	4	3	1	2	2	1	11	16
16–31	9	—	—	1	2	3	8	31	7	1	1	1	1	—	6	32
32–47	1	—	—	—	—	—	2	6	1	—	—	—	—	—	1	6
Over 47 ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total ..	15	1	1	2	7	8	18	48	12	4	2	3	3	1	18	54
m.p.h.	10,000 ft. Total cases, 84. 0–3 m.p.h. 0%.								10,000 ft. Total cases, 83. 0–3 m.p.h. 1%.							
4–15	7	—	2	—	2	5	12	8	1	5	1	4	1	5	13	16
16–31	5	—	—	—	1	6	14	16	5	1	—	—	8	4	6	18
32–47	1	—	—	—	—	7	6	6	1	—	—	1	—	—	5	1
Over 47 ..	—	—	—	—	—	—	1	—	—	—	—	—	—	—	2	—
Total ..	13	—	2	—	3	18	33	30	7	6	1	5	9	9	26	35

	August (1922–30).								September (1921–29).							
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
m.p.h.	1,500 ft. Total cases, 273. 0–3 m.p.h. 2%.								1,500 ft. Total cases, 225. 0–3 m.p.h. 2%.							
4–15	6	4	1	—	1	—	1	6	9	10	2	3	2	—	2	11
16–31	21	3	1	—	—	—	—	21	29	4	1	1	2	1	—	11
32–47	12	—	—	—	—	—	—	14	6	—	—	—	1	—	—	2
Over 47 ..	1	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—
Total ..	40	7	2	—	1	—	1	44	44	14	3	4	5	1	2	24
m.p.h.	3,000 ft. Total cases, 269. 0–3 m.p.h. 3%.								3,000 ft. Total cases, 222. 0–3 m.p.h. 3%.							
4–15	6	3	1	1	—	—	2	8	17	6	1	4	2	2	4	12
16–31	19	1	—	—	—	—	—	40	19	—	—	2	2	—	—	19
32–47	5	—	—	—	—	—	—	8	3	—	—	—	1	—	—	3
Over 47 ..	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Total ..	30	4	1	1	—	—	2	57	39	6	1	6	5	2	4	34
m.p.h.	6,000 ft. Total cases, 213. 0–3 m.p.h. 2%.								6,000 ft. Total cases, 206. 0–3 m.p.h. 3%.							
4–15	9	5	3	—	1	3	10	16	12	4	1	2	2	7	5	16
16–31	8	—	—	—	—	—	10	24	6	1	—	—	4	2	6	21
32–47	2	—	—	—	—	—	—	4	1	—	—	—	—	—	1	4
Over 47 ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total ..	19	5	3	—	1	3	20	44	19	5	1	2	6	9	12	41
m.p.h.	10,000 ft. Total cases, 90. 0–3 m.p.h. 2%.								10,000 ft. Total cases, 112. 0–3 m.p.h. 1%.							
4–15	6	4	6	3	10	6	8	14	8	4	1	5	3	1	9	9
16–31	4	—	—	1	3	—	10	12	6	—	—	—	4	6	12	17
32–47	2	—	—	—	—	—	3	4	1	—	—	—	—	—	7	4
Over 47 ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Total ..	12	4	6	4	13	6	21	30	15	4	1	5	7	7	29	31

Table II—Percentage Frequencies of Upper winds

Shaibah 30° 26′ N. 47° 41′ E. Height 64 feet.

	June (1922–30).								July (1922–30).							
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
m.p.h	1,500 ft. Total cases, 247. 0–3 m.p.h. 1%.								1,500 ft. Total cases, 251. 0–3 m.p.h. 2%.							
4–15	6	5	—	—	1	2	2	4	6	2	—	1	2	1	2	5
16–31	14	3	—	—	1	1	2	14	7	2	—	—	—	—	1	29
32–47	6	—	—	—	—	—	—	30	4	—	—	—	—	—	—	26
Over 47 ..	—	—	—	—	—	—	—	5	—	—	—	—	—	—	—	10
Total ..	26	8	—	—	2	3	4	53	17	4	—	1	2	1	3	70
m.p.h.	3,000 ft. Total cases, 241. 0–3 m.p.h. 1%.								3,000 ft. Total cases, 238. 0–3 m.p.h. 0%.							
4–15	7	5	1	1	1	1	2	7	8	1	4	—	1	1	2	6
16–31	14	1	—	—	2	—	2	23	4	—	—	1	—	—	1	35
32–47	2	—	—	—	—	—	—	24	2	—	—	—	—	—	—	27
Over 47 ..	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	5
Total ..	23	6	1	1	3	1	4	60	14	1	4	1	1	1	3	73
m.p.h.	6,000 ft. Total cases, 174. 0–3 m.p.h. 5%.								6,000 ft. Total cases, 185 0–3 m.p.h. 2%							
4–15	3	2	1	2	2	3	3	17	5	3	3	3	1	3	8	16
16–31	3	1	1	—	1	2	1	32	3	1	2	—	—	1	3	32
32–47	4	—	—	—	—	—	1	15	—	—	—	—	—	1	1	13
Over 47 ..	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	2
Total ..	10	3	2	2	3	5	5	66	8	4	5	3	1	5	12	63
m.p.h.	10,000 ft. Total cases, 64. 0–3 m.p.h. 3%.								10,000 ft. Total cases, 90. 0–3 m.p.h. 1%							
4–15	3	5	—	2	5	5	6	19	6	6	4	6	7	12	8	6
16–31	3	—	—	—	—	5	8	20	4	1	—	2	4	1	9	13
32–47	2	—	—	—	—	2	5	5	—	—	—	—	—	—	6	3
Over 47 ..	—	—	—	—	—	—	3	2	—	—	—	—	—	—	—	1
Total	8	5	—	2	5	12	22	46	10	7	4	8	11	13	23	23

	August (1922–30).								September (1922–29).							
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
m.p.h.	1,500 ft. Total cases, 262. 0–3 m.p.h. 2%.								1,500 ft. Total cases, 218. 0–3 m.p.h. 3%.							
4–15	6	3	1	1	2	1	5	9	8	3	2	6	9	2	5	14
16–31	15	—	—	—	—	—	1	24	12	1	—	—	1	—	2	15
32–47	5	—	—	—	—	—	—	19	5	—	—	—	—	—	—	11
Over 47 ..	1	—	—	—	—	—	—	5	—	—	—	—	—	—	—	1
Total ..	27	3	1	1	2	1	6	57	25	4	2	6	10	2	7	41
m.p.h.	3,000 ft. Total cases, 247. 0–3 m.p.h. 4%.								3,000 ft. Total cases, 211. 0–3 m.p.h. 3%.							
4–15	8	4	4	1	—	—	2	11	12	5	4	7	4	1	4	11
16–31	11	—	—	—	—	1	1	32	10	—	—	1	—	—	1	24
32–47	1	—	—	—	—	—	—	16	3	—	—	—	—	—	—	7
Over 47 ..	1	—	—	—	—	—	—	2	—	—	—	—	—	—	—	1
Total ..	21	4	4	1	—	1	3	61	25	5	4	8	4	1	5	43
m.p.h.	6,000 ft. Total cases, 193. 0–3 m.p.h. 3%.								6,000 ft. Total cases, 167. 0–3 m.p.h. 6%.							
4–15	12	5	4	4	1	3	7	22	11	9	2	5	3	4	6	11
16–31	6	—	1	—	—	1	1	24	5	1	1	2	—	—	5	21
32–47	1	—	—	—	—	—	—	6	2	—	—	—	—	—	—	6
Over 47 ..	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Total ..	20	5	5	4	1	4	8	53	18	10	3	7	3	4	11	38
m.p.h.	10,000 ft. Total cases, 90. 0–3 m.p.h. 3%.								10,000 ft. Total cases, 86. 0–3 m.p.h. 2%.							
4–15	14	8	11	6	9	8	4	12	19	8	5	6	5	3	6	16
16–31	1	1	1	2	2	1	1	11	5	—	—	2	2	2	7	11
32–47	—	—	—	—	—	—	—	3	—	—	—	—	—	—	1	—
Over 47 ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total ..	15	9	12	8	11	9	5	26	24	8	5	8	7	5	14	27

NW., almost without exception ; but at the same time it is to be noted that while in any one month at either station the total percentage frequency of winds from NE., E., SE., S., SW. and W. is practically the same for 3,000 feet as for 1,500 feet, it is definitely greater for 6,000 feet than for the lower heights, and for 10,000 feet than for 6,000 feet, and sometimes very appreciably so. This, therefore, is an indication that northerly and north-westerly winds near the surface rarely show any appreciable change of direction within the first 3,000 feet, but above that height there is a very definite decrease in their frequency and consequently an increasing tendency for a change of direction with height.

Individual single-theodolite pilot-balloon ascents made during the four months under consideration in the 7 years 1923–9 for Hinaidi, and the 8 years 1922–9 for Shaibah provide some further information regarding the nature and frequency of such changes. It has, however, to be borne in mind in this connection that on occasions when the wind is unusually strong at low levels there is a likelihood that the balloon may be lost to view in the distance at only a moderate height and thus the wind at greater heights goes unrecorded. This limitation of the data was specially evident in certain of the months examined, but bearing it in mind and making some allowance for it, it is possible to draw certain useful deductions.

For the purposes of a statistical analysis of these individual ascents an occasion with *strong north-westerly wind* was defined as one on which the wind at 1,500 feet was from between 290° and 360° of speed 20 m.p.h. or more, and a tabulation was then made of all such occasions when a backing of the wind to beyond 270° or a veer to beyond 20° was observed at some height not above 10,000 feet, independent of changes in the wind speed. This definition will in future be referred to as *the specified direction change*. The results are set out in Table III.

TABLE III—DAYS WITH A PILOT-BALLOON ASCENT SHOWING A STRONG NW.'LY WIND AT 1,500 FEET EXHIBITING THE SPECIFIED DIRECTION CHANGE

Month.	Total no. of days.		No. of days with ascent to 1,500 feet or more.		Proportion of these with strong NW.'ly at 1,500 feet as defined above.		Proportion of strong NW.'lies at 1,500 feet showing specified direction change.	
	Hinaidi	Shaibah	Hinaidi	Shaibah	Hinaidi	Shaibah	Hinaidi	Shaibah
					%	%	%	%
June	210	240	206	226	55	65	15	8
July	217	248	210	240	71	75	28	18
August ..	217	248	212	244	67	63	26	15
September ..	210	240	193	222	29	40	25	11

From this table it appears that strong north-westerly winds are most frequent over Iraq in July, and also that both at Hinaidi and Shaibah the proportion of these winds which exhibit the specified direction change is highest in July. At Hinaidi, however, this proportion shows little change in the months July–September, and it is seen that on about one day in four with strong north-westerlies there in those months the specified direction change was observed to occur. The actual frequency of its occurrence must exceed this on account of the occasions when the change went unrecorded owing to the balloon being lost at low altitudes, and in this connection it is instructive to examine the occasions with strong north-westerlies at 1,500 feet on which a balloon was followed to 10,000 feet. As a result of doing this for Hinaidi for the month of July it emerges that on 62 per cent of these occasions the specified direction change was encountered at a height not exceeding 10,000 feet. Comparing this figure with that of 28 per cent given in Table III for the proportion of strong north-westerlies showing the specified direction change, it seems likely that, in a considerable number of cases in which the balloon was lost to view at a low level without the specified direction change being observed, such a change actually existed and would have been revealed at a greater height had the balloon been followed thus far. In June, July and September strong north-westerlies are somewhat more frequent at Shaibah than at Hinaidi, but for the four months combined the specified direction change was observed little more than half as frequently as at Hinaidi.

As regards the height above the ground at which the specified direction change was first encountered, Table IV shows the frequency of its occurrence at various heights for the four months combined.

TABLE IV—FREQUENCY TABLE OF HEIGHT ABOVE GROUND AT WHICH THE SPECIFIED DIRECTION CHANGE OCCURRED

	Height (feet).							
	2,000	3,000	4,000	5,000	6,000	7,000	8,000	10,000
Hinaidi ..	1	1	7	17	20	34	17	12
Shaibah ..	1	3	4	13	19	19	13	7
Total ..	2	4	11	30	39	53	30	19

From this it is seen that the change was most often met with at about 7,000 feet, and seldom below 4,000 feet.

It is further of interest to examine the actual wind direction at the height where the specified change is encountered. Since the change from a strong north-westerly current in the lower

layers to another current above will not always be a discontinuous one but will be in the nature of a steady veering or backing of the wind, it is to be anticipated that the most frequent directions constituting the specified change will be either backed some 10° or 20° from 270° or veered by about the same amount on 20°. This is shown to be the case in Table V, from which it is seen that for Hinaidi and Shaibah combined, in 71 per cent of the occasions exhibiting the specified direction change the actual wind direction at the height where the change occurred was either

TABLE V—PERCENTAGE FREQUENCIES OF WIND FROM VARIOUS DIRECTIONS AT THE HEIGHT AT WHICH THE SPECIFIED DIRECTION CHANGE OCCURRED

	21°–45°.	46°–90°.	91°–135°.	136°–180°.	181°–225°.	226°–269°.	Less than 4 m.p.h.
1. Hinaidi	16	10	2	3	5	60	4
2. Shaibah	14	13	4	4	6	50	9
1 and 2 combined ..	15	11	3	3	6	56	6

between 226° and 269° or between 21° and 45°. There are, however, 29 per cent of occasions on which the wind in the circumstances under consideration was between NE. and SW. (through S.) or of speed less than 4 m.p.h., and thus markedly different from the strong north-westerly current obtaining at 1,500 feet. In order to provide some indication of what further changes in direction tended to occur with increasing height after the specified change had been encountered, a tabulation was made of the wind direction at 10,000 feet, or at the greatest height reached if less than that. The results are given in Table VI

TABLE VI—PERCENTAGE FREQUENCIES OF WIND DIRECTION AT 10,000 FEET, OR AT THE GREATEST HEIGHT REACHED IF LESS THAN THAT, based only on ascents continued above the height (below 10,000 feet) at which the specified direction change occurred.

	1°–45°.	46°–90°.	91°–135°.	136°–180°.	181°–225°.	226°–270°.	271°–315°.	316°–360°.	Less than 4 m.p.h.
1. Hinaidi ..	5	4	10	21	18	25	11	4	2
2. Shaibah ..	6	6	18	20	14	23	6	6	1
1 and 2 combined	5	5	14	20	16	24	9	5	2

It is at once evident from the low frequencies under groups 271°–315° and 316°–360° in this table, that there is very little tendency for the wind direction to revert to north-westerly above the height at which the specified direction change is encountered; in fact, the table indicates that for occasions when a strong north-westerly wind, as previously defined, showed the specified direction change at a height below 10,000 feet the wind direction above that height was between W. and E. through S. on about 75 per cent of those occasions, and between SE. and S. in as many as 20 per cent of cases, these latter constituting a complete reversal from the north-westerly current obtaining at 1,500 feet.

Before making some reference to variations of wind speed with height a few selected examples showing the specified direction change are given in Table VII.

TABLE VII—EXAMPLES OF VARIATION OF WIND WITH HEIGHT ON OCCASIONS WITH A STRONG NORTH-WESTERLY, AS DEFINED ABOVE

Date.	Time G.M.T.	Wind at 1,500 ft.	Specified dir. change.		Wind at greater heights.					
			Ht.	Wind.	Ht.	Wind.	Ht.	Wind.	Ht.	Wind.
		° m.p.h.	ft.	° m.p.h.	ft.	° m.p.h.	ft.	° m.p.h.	ft.	° m.p.h.
					HINAIDI.					
22.6.24	0230	344 ; 22	5,000	261 ; 13	8,000	251 ; 37	10,000	221 ; 31	—	—
21.6.28	0335	337 ; 39	5,000	63 ; 7	8,000	90 ; 3	—	—	—	—
21.7.24	0715	333 ; 47	7,000	250 ; 10	9,000	297 ; 9	—	—	—	—
28.7.26	0400	313 ; 27	5,000	257 ; 7	6,000	150 ; 7	7,000	167 ; 13	10,000	242 ; 6
31.8.24	0230	330 ; 41	8,000	251 ; 8	9,000	106 ; 10	10,000	98 ; 12	—	—
2.8.26	0400	332 ; 50	7,000	39 ; 7	10,000	68 ; 10	—	—	—	—
9.8.27	0400	329 ; 31	7,000	56 ; 5	10,000	160 ; 20	—	—	—	—
12.9.27	0110	340 ; 31	5,000	225 ; 3	6,000	122 ; 4	—	—	—	—
					SHAIBAH.					
4.6.24	0220	354 ; 25	3,000	29 ; 25	4,000	92 ; 28	5,000	167 ; 31	8,000	314 ; 33
5.6.26	0400	322 ; 32	6,000	243 ; 7	8,000	214 ; 18	—	—	—	—
26.7.24	0730	313 ; 28	4,000	256 ; 10	6,000	138 ; 12	—	—	—	—
14.7.25	0400	324 ; 48	7,000	245 ; 11	10,000	165 ; 27	—	—	—	—
13.8.25	0400	342 ; 26	2,000	67 ; 6	5,000	323 ; 5	10,000	133 ; 5	—	—
27.8.27	0400	331 ; 57	7,000	27 ; 6	8,000	63 ; 5	—	—	—	—
1.9.24	0245	322 ; 51	6,000	232 ; 17	8,000	107 ; 12	—	—	—	—

Since the occurrence of the specified direction change indicates in most cases a transition, either continuously or discontinuously, from the strong north-westerly wind below to some other wind current above, it is to be anticipated that the wind speed at the height where the direction change is encountered will, in general, be appreciably or even very markedly less than at 1,500 feet. This is evident in certain of the selected examples included in Table VII; in particular, that for Shaibah on August 27, 1927, in which the wind speed fell from 57 m.p.h. at 1,500 feet to 6 m.p.h. at 7,000 feet, the height at which the specified direction change occurred. It is also emphasised in Table VIII which gives for each of the months considered the mean wind speed at 1,500 feet in the case of strong north-westerly winds showing the specified direction change, and also the mean speed at the height where that change occurred.

TABLE VIII—THE MEAN WIND SPEED AT 1,500 FEET IN ASCENTS WITH A STRONG NW.'LY WIND SHOWING SPECIFIED DIRECTION CHANGE, AND MEAN SPEED AT THE HEIGHT *H* WHERE THAT CHANGE OCCURRED.

Month.	Hinaidi.		Shaibah.	
	1,500 ft.	*H* m.p.h.	1,500 ft.	*H* m.p.h.
June	28	15	31	20
July	29	12	32	11
August	30	11	32	20
September	29	11	35	10

While dealing with the question of wind speed it may be pointed out that, as regards the case in which a strong north-westerly at 1,500 feet does not reveal the specified direction change but continues from between W. and NNE. up to the maximum height to which the balloon is observed, no really representative values can be derived from existing pilot-balloon data for the mean variation of wind speed with height in these circumstances on account of the fact that, as pointed out earlier in this note, a pilot balloon may be lost to view in the distance at only a moderate height when the wind is unusually strong at low levels, thus leaving the wind at greater heights unrecorded. There are some instances available in which such a "solid" north-westerly current was revealed up to 10,000 feet; but since, in general, a balloon would seldom be observable to that height if the strong north-westerly at 1,500 feet was tending to increase appreciably with height, it is probable that mean values of the wind speed at various heights in these circumstances computed from the data available would be, for the greater heights, definitely lower than the true means and thus give an erroneous indication of the normal variation of wind speed with height. It is, however, interesting to note that balloon ascents on 70 occasions in July at Hinaidi, which revealed a strong north-westerly wind at 1,500 feet, and in which the balloon was lost to view between 6,000 and 10,000 feet without the specified direction change having been encountered, gave mean values of the wind speed at 1,500 feet, 3,000 feet and 6,000 feet as follows:—

	Mean speed.
1,500 feet	33 m.p.h.
3,000 feet	27 m.p.h.
6,000 feet	21 m.p.h.

There appears, therefore, to be a definite tendency for strong north-westerlies to decrease in strength with height even when unaccompanied by the specified direction change. It is probable, however, that in some individual cases the decrease in speed at 6,000 feet may represent the approach to the specified direction change existing at a slightly greater height.

Summary.—From the analysis of pilot-balloon ascents in Iraq described in this note the following main features emerge :—

1. Out of the occasions in July at Hinaidi on which the wind at 1,500 feet is from between 290° and 360°, 20 m.p.h. or more, a backing of the wind to beyond 270° or a veer to beyond 20° may be anticipated to occur at some height not above 10,000 feet on at least one occasion out of four, or taking the Tigris-Euphrates valley in general for the months June to September, inclusive, the frequency is at least one occasion out of five. There is, however, reason to believe that the actual frequencies may be as high as one occasion out of two.

2. The height at which this change is encountered is generally between 5,000 and 8,000 feet, with the greatest frequency at 7,000 feet.

3. The wind above the height where the change occurs seldom reverts to north-westerly, and in about one case out of five exhibiting the change a complete reversal to between SE. and S. of the strong north-westerly at 1,500 feet may be expected at a height not exceeding 10,000 feet.

4. The wind speed at the height where the change occurs is usually very much less than at 1,500 feet.

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